

Superpages for ARMv7: Introduction and Status

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Presentation outline

- ▶ Motivation
- ▶ Introduction to *Superpages*
- ▶ Implementation for ARMv6/v7
- ▶ Validation and benchmarking
- ▶ What's next?

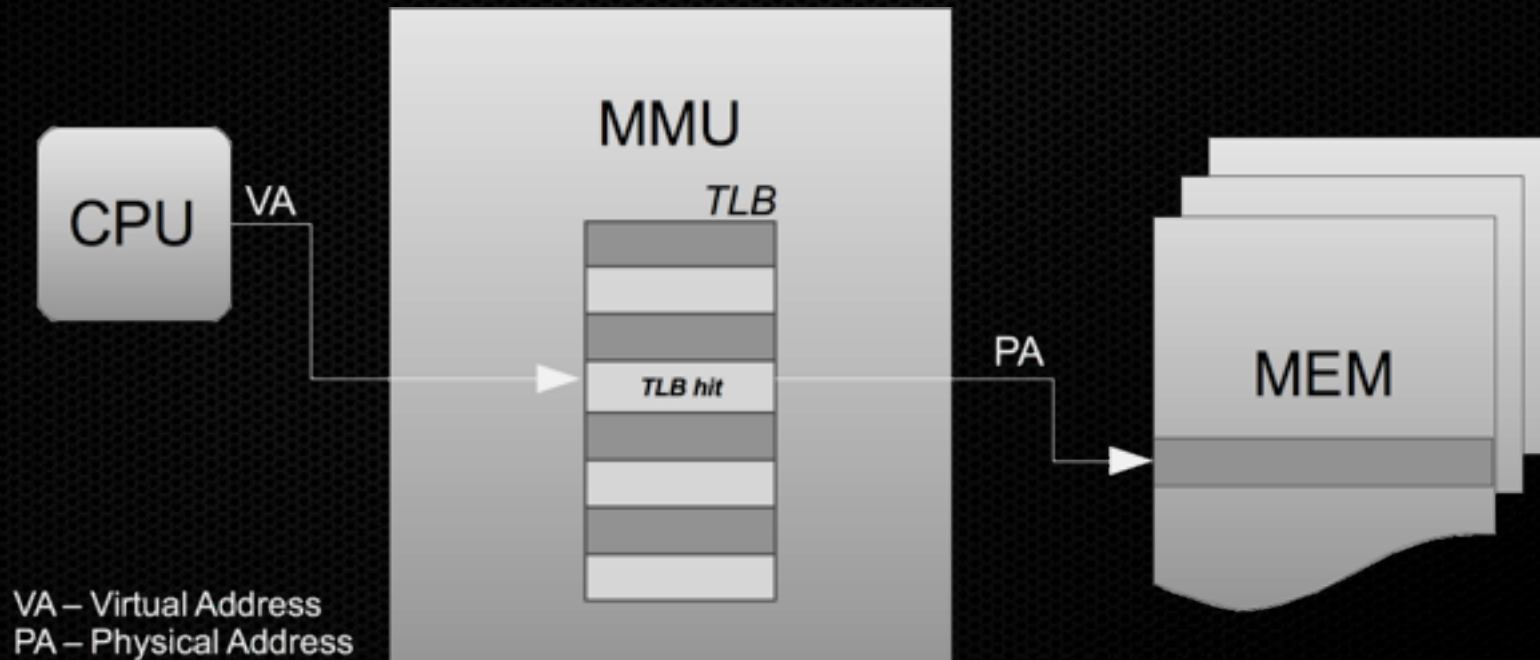
Motivation

- ▶ ARM is expanding into new promising markets
 - ▶ ARM-based server concept
 - ▶ Need for SW that will take full advantage of HW capabilities
- ▶ Sophisticated features - key to FreeBSD success in the new areas



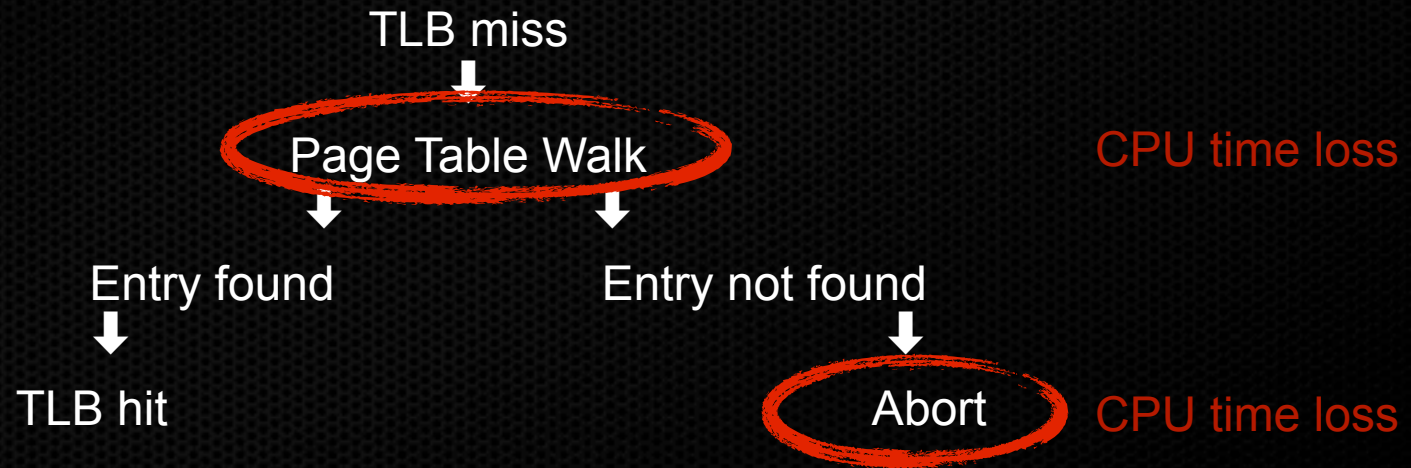
Introduction to *Superpages*

▶ Accessing memory on ARM



Introduction to *Superpages*

▶ Accessing memory on ARM



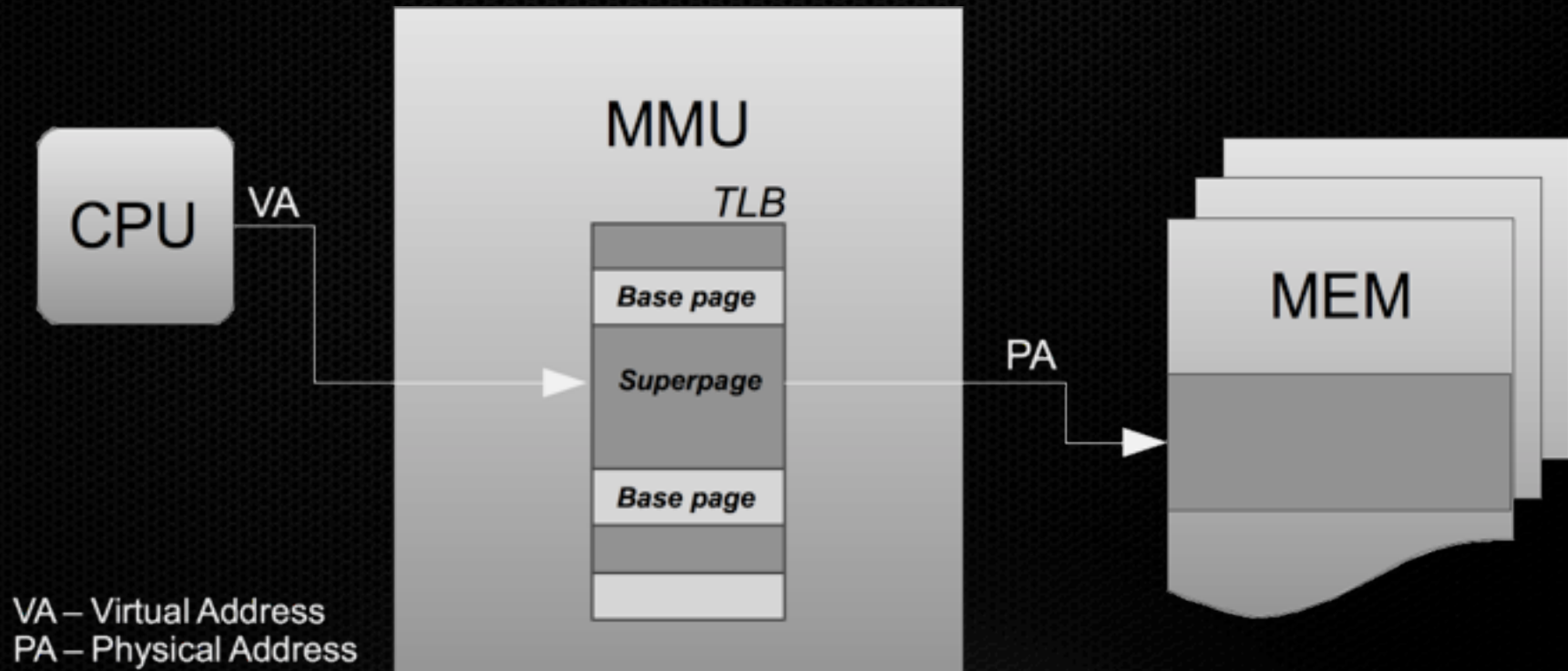
Introduction to *Superpages*

- ▶ Accessing memory on ARM
- ▶ Limitations
 - ▶ Small TLBs (due to speed restrictions)
 - ▶ 4 KB page size
 - ▶ to maintain dense granulation and hence small fragmentation factor

SMALL TLB COVERAGE

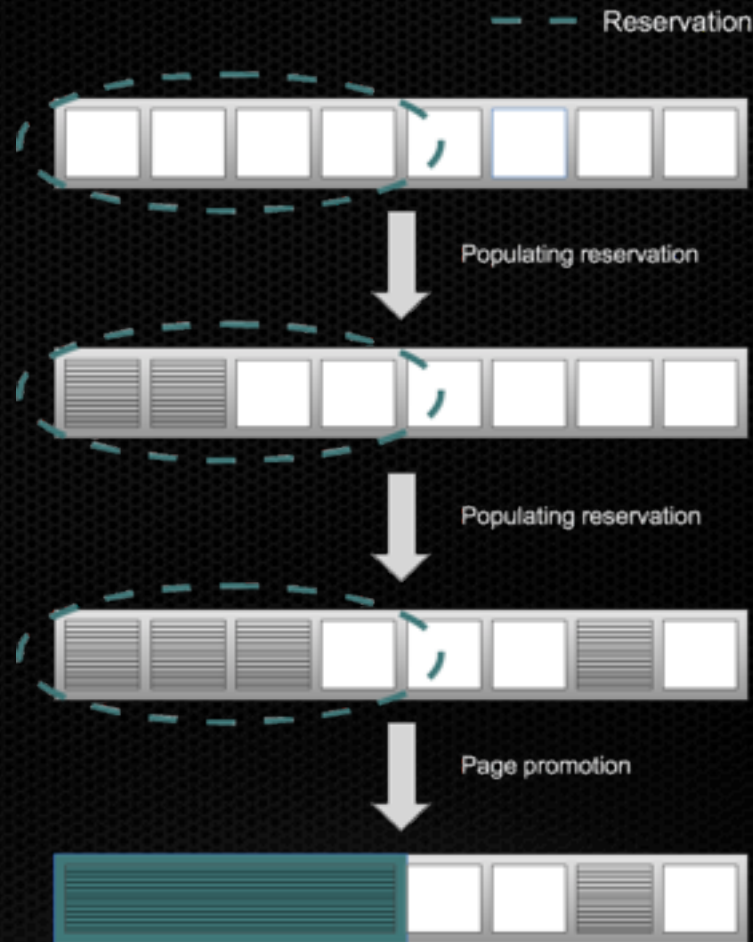
Introduction to *Superpages*

- ▶ *Superpages* technique overcomes this issue
 - ▶ Reducing TLB misses



Introduction to *Superpages*

▶ Reservation-based allocation



Implementation for ARMv6/v7

- ▶ Introduced support for machine-dependent portion of *Superpages* mechanism
 - ▶ promotion
 - ▶ demotion
 - ▶ creation
 - ▶ removal
 - ▶ shared mappings management
 - ▶ modifications of the *pmap* module

Implementation for ARMv6/v7

- ▶ Preparatory *pmap* improvements
 - ▶ PV entry allocator
- ▶ Introduced support for machine-dependent portion of *Superpages* mechanism
 - ▶ Support for two page sizes
 - ▶ 4 KB small page (base page)
 - ▶ 1 MB section (superpage)
 - ▶ One superpage instead of 256 base pages
 - ▶ Only non-kernel, managed mappings

Validation and benchmarking

▶ Test tools

- ▶ GUPS (Giga Updates Per Second)
- ▶ LMbench (STREAM)
- ▶ RAMspeed
- ▶ Self-host world build

▶ Test platform

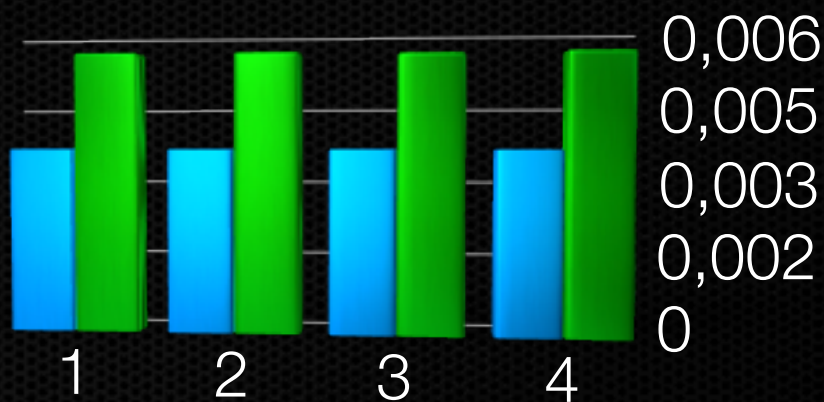
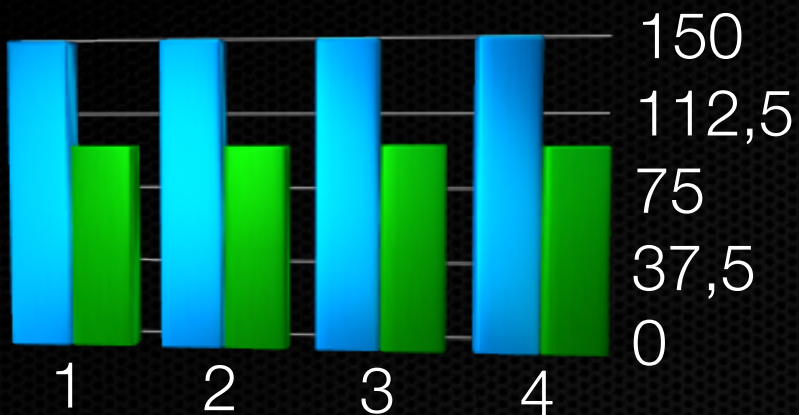
- ▶ Armada XP (quad PJ4Bv7)
- ▶ Other (Raspberry-Pi)

Validation and benchmarking

CPU Time [s]

Updates [bn/s]

SP OFF
SP ON



GUPS

Mmap reread %	Bcopy (libc) %	Bcopy (hand) %	Mem read %	Mem write %	Rand mem latency %
2,26	2,29	3,37	2,2	8,44	37,85

LMbench

GCC	CLANG	
6h 36min	6h 16min	SP OFF
5h 14min	6h 15min	SP ON

World build



What's next?

- ▶ Support for 64 KB pages
 - ▶ Further performance improvement
 - ▶ More applications can use superpages
- ▶ Move all status flags from PV to PTE
 - ▶ Less overhead on promotion failure
 - ▶ Faster page management

References

- ▶ Project's wiki page

<http://wiki.freebsd.org/ARMSuperpage>

- ▶ Article on ARM blogs

<http://blogs.arm.com/software-enablement/1079-transparent-superpages-for-freebsd-on-arm>

Any questions?